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Redescription of the perciform fish *Symphysanodon disii* (Symphysanodontidae) from the Gulf of Aqaba, Red Sea, with comments on *S. pitondelafournaisei* and sexual dimorphism in the genus

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Abstract

Symphysanodon disii was described in 2008 from a single specimen collected in October 1999 from the Gulf of Aqaba. More recently, March 2008, four additional specimens of this species were collected in the Gulf. The following characters in combination distinguish *S. disii* from the other species in the genus: parapophyses on the first caudal vertebra, tubed scales in the lateral line 48 to 50, total number of first-arch gillrakers 34 to 37, sum of total number of gillrakers plus lateral-line scales (in individual specimens) 82 to 87, pectoral-fin rays 16 or 17, fleshy orbit diameter 7.2 to 8.3 % SL, and second anal-spine length 8.3 to 9.7 % SL. We redescribe *S.disii*, comment on *S. pitondelafournaisei* from the southwestern Indian Ocean off Reunion Island, and discuss sexual dimorphism in the genus.

Key words: *Symphysanodon*, Gulf of Aqaba, Reunion Island, sexual dimorphism

Introduction

The marine fish family Symphysanodontidae contains a single genus, *Symphysanodon* Bleeker, 1878, and 12 described species (Anderson and Bineesh, 2011; Anderson and Springer, 2005; Khalaf and Krupp, 2008; Quéro *et al.*, 2009). In addition, McCosker (1979) and Anderson and Springer (2005) reported a species of *Symphysanodon*, as yet undescribed, that was obtained from the stomach of a coelacanth (*Latimeria chalumnae*) caught in the Comoros in the southwestern Indian Ocean. Later Heemstra *et al.* (2006) mentioned an undescribed species of *Symphysanodon* from the Comoros that may be conspecific with the species reported from the coelacanth stomach. Also, Campos *et al.* (2009) reported two larval *Symphysanodon*, collected off southern Brazil, that may represent another undescribed species. In view of the fact that the genus *Symphysanodon* is not well known, with most species poorly represented in museum collections, it seems likely that other species await discovery.

Symphysanodon (with adults reaching less than 175 mm SL) occurs in depths of about 80 to 700 m in the Atlantic, Pacific, and Indian oceans. Five species of *Symphysanodon* have been described from the Indian Ocean (*sensu lato*), *viz*., *S. andersoni* Kotthaus, 1974 (southwest of Socotra Island, near the entrance to the Gulf of Aden; also reported from the Gulf of Kutch, an inlet in the northeastern quadrant of the Arabian Sea on the west coast of India by Manilo and Bogorodsky, 2003); *S. rhax* Anderson and Springer, 2005 (off the Maldive Islands); *S. disii* Khalaf and Krupp, 2008 (Gulf of Aqaba); *S. pitondelafournaisei* Quéro *et al.*, 2009 (off Reunion Island); and *S. xanthopterygion* Anderson and Bineesh, 2011 (Arabian Sea off southern India). Herein we redescribe *S. disii* based on the holotype and four additional specimens caught in the Gulf of Aqaba, comment on *S. pitondelafournaisei* collected off Reunion Island, and discuss sexual dimorphism in the genus.

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Methods and abbreviations

Methods used are those of Anderson (1970) and Anderson and Springer (2005). Institutional abbreviations are: GMBL—Grice Marine Biological Laboratory, Charleston, South Carolina; MNHN—Muséum National d'Histoire Naturelle, Paris; MSSA—Marine Science Station, Aqaba, Jordan; TAU—Zoological Museum, Tel Aviv University, Tel Aviv Israel; USNM—National Museum of Natural History, Smithsonian Institution, Washington, DC. SL denotes standard length.

Symphysanodon disii Khalaf and Krupp, 2008

Disi's Slopefish

(Figures 1, 2; Tables 1, 2)

Symphysanodon disii Khalaf and Krupp, 2008:86, figs. 1, 2; table I (original description, illustrations; holotype MSSA 64-20/1, 163 mm SL; type locality Gulf of Aqaba, Red Sea , off Aqaba, Jordan, ca. 150 m depth).

Diagnosis. A species of *Symphysanodon* distinguishable from the other species of the genus by the following combination of characters. First caudal vertebra with parapophyses. Total gillrakers on first arch 34 to 37. Lateral-line scales 48 to 50. Sum of total number of gillrakers plus lateral-line scales, in individual specimens, 82 to 87. Diameter of fleshy orbit 7.2 to 8.3 % SL. Depth of body 27.8 to 31.1 % SL. Length of pectoral fin 27.5 to 29.2 % SL. Length of anal-fin base 16.5 to 18. 0 % SL. Length of depressed anal-fin 31.1 to 34.9 % SL. Length of second anal spine 8.3 to 9.7 % SL. Head and body mostly red orange to rosy, caudal fin mainly rosy or purplish rose.

Description. Morphometric data appear in Table 1. Data for countable characters follow (some of which also appear in Table 2); values for the holotype are indicated by asterisks for characters having variable counts. Branchiostegals 7. Dorsal-fin rays IX, 10. Anal-fin rays III, 7. Pectoral-fin rays 16* or 17.* Pelvic-fin rays I, 5. Caudal-fin rays: principal 17 (9 + 8); branched 15 (8 + 7); procurrent 12 or 13* dorsally, 11 or 12* ventrally. Gillrakers on first arch 9 to 11* + 24 to 26* (total 34 to 37*). Tubed lateral-line scales ca. 48 to 50*. Sum of total number of gillrakers plus lateral-line scales, in individual specimens, 82 to 87*. No spur on posteriormost ventral procurrent caudal-fin ray, but penultimate ventral procurrent caudal-fin ray shortened basally (see Johnson, 1975). Vertebrae 25 (10 precaudal + 15 caudal). Formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores 0/0/0 + 2 + 1/1/1/ (using notation of Ahlstrom *et al.*, 1976). First caudal vertebra with parapophyses. Short neural spine on second preural centrum. Uroneurals 2 pairs. Autogenous haemal spine associated with second preural centrum. Parhypural autogenous, bearing a hypurapophysis. Hypurals 1 and 2 fused, hypurals 3 and 4 fused; lines of fusion visible. Hypural 5 autogenous. Epurals 3. Epineurals associated with first 9 or 10* vertebrae. Pleural ribs on vertebrae 3 through 10. Trisegmental pterygiophores: 2 or 3* associated with dorsal fin, 3 with anal fin.

Snout relatively blunt. Anterior ends of premaxillae incised, forming a notch that receives anterior ends of dentaries. Dorsalmost margin of maxilla covered by very narrow suborbital with mouth closed. Mouth terminal; lower jaw inclined dorsally with mouth closed; jaws about equal. Maxilla reaching posteriorly to a vertical well beyond middle of eye. Anterior and posterior nares fairly closely set on each side of snout. Pseudobranchiae present. Interorbital region flattened to slightly convex. Opercle with two flattened spines. Both limbs of preopercle usually without serrae, margins almost smooth; angle of preopercle without spine, but may be somewhat roughened, bifid spine-like process present on left side of one specimen, and enlarged serra just above angle on right side of holotype. Dorsal fin continuous and not incised at junction of spines and segmented rays. Scales ctenoid (with ctenial bases in posterior fields proximal to marginal cteni—see Hughes, 1981; this is the transforming ctenoid scale of Roberts, 1993). Most of head, including maxillae, dentaries, lachrymals, dorsal and lateral aspects of snout, and interorbital region with scales. Branchiostegals and branchiostegal membranes without scales, gular region usually without scales. Dorsal and anal fins without scales (occasionally a few scales on some anal soft rays), but with scaly sheaths at their bases; pectoral and pelvic fins scaly basally; both lobes of caudal fin scaly. Large modified scales associated with pelvic fin, just dorsal to pelvic spine (axillary scales) and in ventral midline between the pelvic fins (interpelvic scales). Lateral line gently curved beneath dorsal fin. Caudal fin well forked.

Premaxilla with outer series of small conical teeth and inner band of much smaller teeth; anteriorly, teeth in outer series considerably enlarged; premaxillary notch toothless. Dentary with band of small conical teeth extend-

ing from elevated posterodorsal surface of jaw almost to symphysis; numerous teeth at anterior end of jaw adjacent to symphysis and on elevated posterodorsal surface of jaw conspicuously enlarged; many of enlarged teeth at anterior end of jaw exserted and fitting into premaxillary notch when mouth closed; symphysis toothless. Vomer and palatine with teeth; vomerine tooth patch small, chevron shaped or quadrangular, without posterior prolongation; palatine teeth in longitudinal band. Endopterygoid usually with teeth. Tongue with or without teeth. Four of the five specimens examined are males; they have the dentition much better developed than does the single female (see Fig. 2).

TABLE 1. Morphometric data for *Symphysanodon disii* from the Gulf of Aqaba. Standard lengths in mm, other measurements in percentages of standard length. Holotype: MSSA 64-20/1. Dam. = damaged; > = slightly damaged.

Character	TAU P. 13320 1 of 2	TAU P. 13321 2 of 2	TAU P. 13321 1 of 2	TAU P. 13320 2 of 2	MSSA 64-20/1
Standard length	146	148	157	159	163
Head, length	28.3	27.7	27.7	27.6	27.9
Head, depth	20.0	19.5	23.5	21.4	21.8
Snout, length	6.3	5.2	5.6	5.6	5.7
Fleshy orbit, diameter	8.2	7.2	7.8	8.3	7.9
Postorbital length of head	13.6	14.1	13.6	12.0	13.2
Cheek, height	6.6	5.9	6.7	6.2	6.9
Upper jaw, length	13.0	13.0	13.7	13.9	13.7
Lower jaw, length	13.6	14.1	13.7	14.3	14.7
Bony interorbital, width	8.7	8.0	7.7	8.1	8.1
Body, depth	27.8	Dam.	27.9	30.1	31.1
Caudal peduncle, depth	11.6	12.4	11.1	11.9	12.9
Caudal peduncle, length	26.6	24.9	25.8	27.4	25.8
Anal fin, length of base	16.5	16.8	17.4	17.0	18.0
Depressed anal fin, length	31.1	33.9	Dam.	34.9	32.8
Pectoral fin, length	27.5	29.0	28.7	29.2	28.3
Pelvic fin, length	25.0	ca. 24	25.1	ca. 25	23.7
Upper caudal-fin lobe, length	>40	ca. 61	ca. 59	52.8	55.3
Lower caudal-fin lobe, length	Dam.	ca. 56	Dam.	ca. 47	48.6
First dorsal spine, length	6.3	6.1	> 5.7	5.3	4.9
Fourth dorsal spine, length	12.0	Dam.	Dam.	11.7	11.1
Last dorsal spine, length	12.0	11.6	11.7	11.9	11.6
Longest dorsal spine, length	7th--12.6	___	___	9th--11.9	9th--11.6
First anal spine, length	5.7	>4.8	5.3	4.8	5.5
Second anal spine, length	9.2	8.3	9.2	9.7	9.7
Third anal spine, length	11.3	10.8	11.5	11.5	11.9

Coloration. Khalaf and Krupp (2008:87) described the coloration of the holotype of *S. disii* as: "Flanks of the freshly caught specimen . . . red, turning to a lighter pinkish ventrally and to dark orange-red dorsally; indistinct, broad, yellow-orange, longitudinal band from operculum to caudal peduncle (hardly visible); dorsal fin yellow, caudal fin reddish orange, with yellow hind-margin on upper lobe; anal, pectoral and pelvic rays light reddish, membranes transparent and without pigmentation."

FIGURE 1. *Symphysanodon disii* (TAU P. 13320, 159 mm SL), Gulf of Aqaba. Photographed by Avi Baranes.

The color photograph of the freshly collected holotype in the original description (Khalaf and Krupp, 2008:86, fig. 1) shows the head to be mainly red orange; body to be mostly red orange dorsally above faintly visible yellowish band running from opercle to about middle of caudal peduncle, rose in broad swath ventral to yellowish band; iris mainly orange to red orange with some blackish pigment anterodorsally; dorsal fin yellow, pectoral fin rosy, anal and pelvic fins rosy with transparent membranes, caudal fin mainly rosy overlain by yellowish on ventral border of upper lobe. A color photograph of one of the TAU specimens (Fig. 1; TAU P. 13320, 159 mm SL) shows it to have coloration similar to that of the holotype, differing in the iris being more yellow and the caudal fin almost entirely purplish rose with narrow yellowish borders along inner margins of both lobes.

TABLE 2. Miscellaneous data on *Symphysanodon disii* from the Gulf of Aqaba. Holotype: MSSA 64-20/1; for bilateral counts left side is presented first; GR + LL scales = sum of total number of gillrakers and tubed lateral-line scales; A = anal; D = dorsal; V = ventral; TMM = too many scales missing to make count.

Character	TAU P. 13320 1 of 2	TAU P. 13321 2 of 2	TAU P. 13321 1 of 2	TAU P. 13320 2 of 2	MSSA 64-20/1
Sex	female	male	male	male	male
Standard length (mm)	146	148	157	159	163
Pectoral-fin rays	17, 17	17, 17	17, 17	17, 17	17, 16
Procurrent caudal-fin rays	D: 13, V: 12	D: 12, V: 12	D: 12, V: 11	D: 12, V: 11	D: 13, V: 12
Total 1st arch gillrakers	34	36	ca. 34	36	37
Lateral-line scales	49, 49	TMM	ca. 48, ca. 49	50, 50	50, 50
GR + LL scales	83	____	ca. 82, ca. 83	86	87
Trisegmental pterygiophores	D: 3, A: 3	D: 3, A: 3	D: 2, A: 3	D: 3, A: 3	D: 3, A: 3
Epineurals, pairs	9	10	10	10	10

Comparisons. *Symphysanodon disii* has parapophyses on the first caudal vertebra whereas the Atlantic species *S. berryi, S. mona*, and *S. octoactinus,* the Pacific species *S. maunaloae* and *S. parini*, and the Indian Ocean species *S. rhax* lack those processes. Number of tubed lateral-line scales distinguishes *S. disii* (with 48–50) from the Indian Ocean species *S. andersoni* (with 60 or 61), total number of gillrakers on first gill arch separates *S. disii*

(with 34–37) from *S. andersoni* (with 41 or 42) and the undescribed species from the Comoros (with 28), sum of total number of gillrakers plus lateral-line scales (in individual specimens) distinguishes *S. disii* (with 82 to 87) from *S. xanthopterygion* (with 94 to 101), number of pectoral-fin rays separates *S. disii* (with 16 or 17) from *S. pitondelafournaisei* (with 15), diameter of fleshy orbit differentiates *S. disii* (7.2–8.3 % SL) from the Pacific species *S. typus* (8.1–12.0 % SL), and length of second anal spine distinguishes *S. disii* (8.3–9.7 % SL) from the Pacific species *S. katayamai* (9.8–10.4 % SL). In addition, live coloration can be used to distinguish *S. disii* from the other species for which coloration is known, *viz*., *S. berryi, S. katayamai*, *S. maunaloae, S. pitondelafournaisei, S. typus*, and *S. xanthopterygion*.

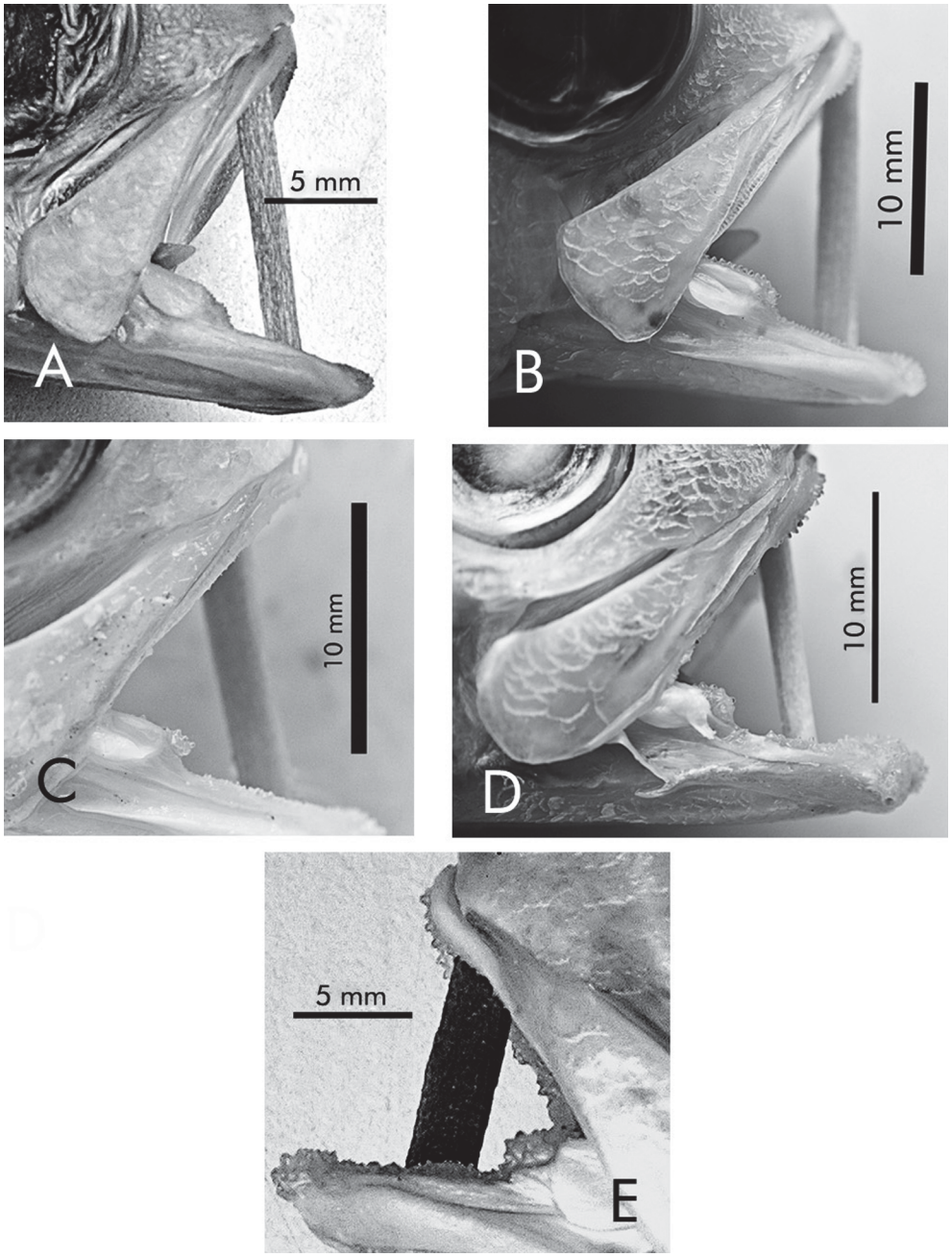

FIGURE 2. Dentition on jaws of *Symphysanodon disii*. A. TAU P. 13320, 146 mm SL, female. B. TAU P. 13320, 159 mm SL, male. C. TAU P. 13321, 148 mm SL, male. D. Holotype, MSSA 64-20/1, 163 mm SL mm SL, male. E. TAU P. 13321, 157 mm SL, male. Digital photographs by Sean Money, computer enhanced by Albert E. Sanders (Charleston Museum).

Sexuality. Histological sections of the gonads of the five known specimens of *S. disii* show one (TAU P. 13320, 146 mm SL) to be a mature female with evidence of recent spawning. The other four specimens are males: TAU P. 13320, 159 mm SL, spawning; TAU P. 13321, 157 mm SL, mature; TAU P. 13321, 148 mm SL (tissue

badly degraded); holotype, 163 mm SL (tissue badly degraded). In the original description (Khalaf and Krupp, 2008), the sex of the holotype was given as female.

Distribution. *Symphysanodon disii* is known only from the northern Gulf of Aqaba off Aqaba (Jordan) and Eilat (Israel).

Material examined. Five specimens, 146 to 163 mm SL.

Holotype: MSSA 64-20/1, 163 mm SL; Gulf of Aqaba, in front of phosphate port at Aqaba, Jordan (Aqaba is at 29°31' N, 35°00'E); depth: ca. 150 meters; 05 October 1999; M. A. Khalaf.

Other material: Gulf of Aqaba off Eilat, Israel (Eilat is at 29°33' N, 34°57'E); depth: 150 meters; 12 March 2008— TAU P. 13320, two specimens, 146–159 mm SL; TAU P. 13321, two specimens, 148–157 mm SL.

Symphysanodon pitondelafournaisei

It seems appropriate to comment here on another recently described species of *Symphysanodon*, *S. pitondelafournaisei* Quéro, Spitz, and Vayne, 2009, known from two specimens (90 & 99 mm SL) collected at the surface off Réunion Island (Mascarene Islands), southwestern Indian Ocean (at 21°07'S, 55°32'E), in April 2007, after an eruption of the volcano Piton de la Fournaise. Although we have not examined either specimen, radiographs of the holotype of *S. pitondelafournaisei* (MNHN 2008-0151, 99 mm SL) show it to have 25 (10 precaudal + 15 caudal) vertebrae, parapophyses on the first caudal vertebra, configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores 0/0/0 + 2 + 1/1/1/, three epural bones, and 17 (9 + 8) principal caudal-fin rays (in contrast with the count of 19 given in the original description).

Symphysanodon pitondelafournaisei is distinguishable from all other known species of *Symphysanodon* by the following combination of characters: parapophyses present on the first caudal vertebra, pectoral-fin rays 15, total number of gillrakers on first arch 34 to 36, tubed lateral-line scales 48 to 50, sum of total number of gillrakers plus tubed lateral-line scales 84. Based on the color photograph published in the original description (Quéro *et al.*, 2009:75, fig. 2), *S. pitondelafournaisei* displays a pattern of coloration which distinguishes it from *S. berryi, S. disii*, *S. katayamai*, *S. maunaloae, S. typus*, and *S. xanthopterygion*, and which may allow it to be separated from the other species of *Symphysanodon* for which no information on live coloration is currently available.

In the original description (Quéro *et al.*, 2009:74) the coloration was described as:

> D'après photographie à l'état frais . . . le corps de l'holotype est saumon dorsalement, argenté ventralement; les nageoires dorsale, anale et caudale sont jaunes. L'iris est jaunâtre. Une tache jaune au-dessus du bord antérieur de la base des pectorales semble être présente; le corps du paratype et ses nageoires sont brun-rougeâtre. Dans l'alcool le corps de l'holotype est gris–jaunâtre, plus foncé dorsalement, plus argenté ventralement; le paratype a le dos gris-saumoné.
> (= According to the photograph of the fresh state . . . the body of the holotype is salmon dorsally, silvery ventrally; dorsal, anal and caudal fins are yellow. The iris is yellowish. A yellow spot above the anterior border of the base of the pectoral [fin] apparently present; the body of the paratype and its fins are reddish brown. In alcohol the body of the holotype is yellowish grey, darker dorsally, more silvery ventrally; the paratype has the back grey salmon.)

The published color photograph (Quéro *et al.*, 2009: 75, fig. 2) shows the head and body of *S. pitondelafournaisei* to be mainly reddish with a broad yellow band running from posterior part of opercle to caudal peduncle where it narrows appreciably and becomes indistinct, iris mainly yellow but with red dorsally, dorsal fin yellow green, pectoral fin red orange, anal and pelvic fins pallid to transparent, both lobes of caudal fin mainly bright yellow basally, yellow green distally with produced filamentous ends of lobes reddish.

Sexual dimorphism in *Symphysanodon.* As noted by Anderson (1970), *S. berryi* is sexually dimorphic in dentition and in lengths of the pelvic fin and lobes of the caudal fin. Length of pelvic fin varying in females from 21 to 25 % SL and in males more than ca. 85 mm SL from 30 to >87 % SL. The caudal fin is deeply forked with upper and lower lobes produced into long filaments in large males, increasing in length with increase in SL. Length of upper lobe of caudal fin varying in females more than ca. 80 mm SL from 30 to >35 % SL and in males more than ca. 85 mm SL from 34 to >128% SL. Length of lower lobe of caudal fin varying in females more than ca. 80

mm SL from 30 to >34% SL and in males more than ca. 85 mm SL from 32 to >111 % SL. In addition, the dentition is better developed and coarser in males than in females.

Anderson (1970:338) found that seven (62–86 mm SL) of the 30 specimens of *S. maunaloae* that he examined "have the pelvic fin well produced (with the medial branch of the first pelvic soft ray reaching anterior part of base of anal fin or beyond), whereas in the other specimens (47–86 mm SL) the pelvic fin, although usually produced, falls short of the anal fin." Although he had only limited success at determining the sex of the available specimens, he wrote that: "It seems, however, that the well-produced pelvic fin is a male characteristic (as it is in *S. berryi*)." Tameka (1982:372) noted that: "First soft ray of pelvic fin elongated in male, reaching backward beyond base of anal fin or to caudal fin. Pelvic fin of female not elongated." Anderson (1970) reported that the pelvic fin varied from ca. 22 to >54 % SL. In 16 (79–141 mm SL) of an additional 48 specimens, Anderson and Springer (2005) found the pelvic fin to be considerably produced, ranging from ca. 42 to >80 % SL. Gross examination of the gonads of two of those specimens (120 & 128 mm SL) showed them to be males.

Anderson (1970) reported the length of upper lobe of caudal fin of *S. maunaloae* to range from ca. 31.2 to ca. 48.9 % SL and the length of lower lobe to range from ca. 30.0 to ca. 43.1 % SL. Measurements of the additional specimens mentioned by Anderson and Springer (2005) extend those ranges to 29 to ca. 75 % SL for upper lobe and ca. 28 to ca. 76 % SL for lower lobe. Two of those specimens (120 & 128 mm SL) with very long caudal-fin lobes are males (see above). Well-produced pelvic fins and caudal-fin lobes appear to be characteristic of males in *S. maunaloae*, as they are in *S. berryi*.

Based on histological examination two (134 & 136 mm SL) of the six known specimens of *S. rhax* are female (Anderson and Springer, 2005). Those two and two others have short pelvic fins (20- >26% SL); the remaining two (136 & 144 mm SL) have produced pelvic fins (>64 & > 67 % SL). "Because both specimens known to be female by histological examination have short pelvic fins and because females of the apparent closest relative of this species, *S. berryi*, have short pelvic fins (in contrast with males which frequently have very well-produced pelvic fins), it is reasonable to assume that the individuals of *S. rhax* with produced pelvic fins are males" (Anderson and Springer, 2005:21). As noted above, *S. berryi* also exhibits sexual dimorphism in lengths of caudal-fin lobes. Damage to both caudal-fin lobes on all six specimens of *S. rhax* precludes answering the question of sexual dimorphism in this character.

Sex was determined histologically in all five specimens of *S. disii* (one female, 146 mm SL; four males, 148–163 mm SL). The dentition is much better developed in the males than in the female (see above for details of dentition in *S. disii*, and Fig. 2), suggesting that there are differences in diets or dietary preferences between the sexes or that these distinctions in dentition may relate to spawning behavior. The sexual dimorphism displayed in the pelvic and caudal fins of *berryi*, *maunaloae*, and *rhax* may function in sexual recognition or may indicate that males and females exploit, at least in part, somewhat different habitats or under certain conditions display different patterns of behavior. We are aware of no other species of *Symphysanodon* that have obvious sexual dimorphism. This is not surprising in view of the fact that most species for which sexual dimorphism has not been observed are represented in museum collections by a small or relatively small numbers of juvenile and adult specimens.

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